

12/16/99
JCS88 U.S. PTO

12-20-99

A

UTILITY PATENT APPLICATION TRANSMITTAL <small>(Only for new non-provisional applications under 37CFR§1.53(b))</small>		Attorney Docket No.	7146.055
		First Inventor or Application Identifier	Bryan S. Hallberg
		Title	METHOD AND APPARATUS FOR STORING MPEG-2 TRANSPORT STREAMS USING A CONVENTIONAL DIGITAL VIDEO RECORDER
		Express Mail Label No.	EL399605856US

APPLICATION ELEMENTS <small>See MPEP chapter 600 concerning utility patent application contents.</small>	ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, D.C. 20231
---	--

1. <input checked="" type="checkbox"/> *Fee Transmittal Form (e.g. PTO/SB/17) <small>(Submit an original and a duplicate for fee processing)</small>	5. <input type="checkbox"/> Microfiche Computer Program (Appendix)
2. <input checked="" type="checkbox"/> Specification <small>(preferred arrangement set forth below)</small> - Descriptive Title of the Invention - Cross References to Related Applications - Statement Regarding Federally Sponsored Research - Reference to Microfiche Appendix - Background of the Invention - Brief Summary of the Invention - Brief Description of the Drawings (if filed) - Detailed Description - Claim(s) - Abstract of the Disclosure	6. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary) a. <input type="checkbox"/> Computer readable copy b. <input type="checkbox"/> Paper copy (identical to computer copy) c. <input type="checkbox"/> Statement verifying identity of above copies
3. <input checked="" type="checkbox"/> Drawing(s) (35 USC 113) [Total Pages 6]	7. <input checked="" type="checkbox"/> Assignment Papers (cover sheet & document(s))
4. Oath or Declaration [Total Pages 3] a. <input checked="" type="checkbox"/> Newly executed (original or copy) b. <input type="checkbox"/> Copy from a prior application (37 CFR §1.63(d)) <small>(for continuation/divisional with Box 16 completed)</small> i. <input type="checkbox"/> Deletion of Inventor(s) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR §§1.53(d)(2) and 1.33(b)	8. <input checked="" type="checkbox"/> 37 CFR §3.73(b) Statement <input checked="" type="checkbox"/> Power of Attorney when there is an assignee 9. <input type="checkbox"/> English translation document (if applicable) 10. <input type="checkbox"/> Information Disclosure Statement (IDS) /PTO 1449 11. <input type="checkbox"/> Preliminary Amendment 12. <input type="checkbox"/> Return Receipt Postcard (MPEP 503) <small>(should be specifically itemized)</small> 13. <input type="checkbox"/> *Small Entity Statements (PTO/sb/09-12) <input type="checkbox"/> Statement filed in prior application. Status still proper and desired. 14. <input type="checkbox"/> Certified Copy of Priority Document(s) <small>(if foreign priority is claimed)</small> 15. <input checked="" type="checkbox"/> Other Associate Power of Attorney

* Note for Items 1 & 13: In order to be entitled to pay small entity fees, a small entity statement is required (37 CFR §1.27), except if one filed in a prior application is relied upon (37 CFR §1.28)

16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: ____/____

Prior application information: Examiner _____ Group No./Art Unit _____

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS					
<input type="checkbox"/> Customer Number or Bar Code Label		(Insert customer number or attach bar code label here)		or <input checked="" type="checkbox"/> Correspondence address below	
Name	Chernoff, Vilhauer, McClung & Stenzel L.L.P.				
Address	1600 ODS Tower 601 S.W. Second Avenue				
City	Portland	State	Oregon	Zip Code	97204-3157
Country	U.S.A.	Telephone	(503) 227-5631	FAX	(503) 228-4373
Name (print type)	Timothy A. Long		Registration No. (Attorney/Agent)	28,876	
Signature	<i>Timothy A. Long</i>		Date	December 16, 1999	

JCS88 U.S. PTO
09/465415
12/16/99

CERTIFICATE OF MAILING

BY "EXPRESS MAIL"

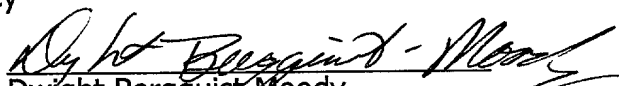
Express Mail No. EL399605856US

Date of Deposit: December 16,1999

I hereby certify that the documents listed below and attached hereto, submitted by Bryan S. Hallberg and Jeffrey B. Sampsell, for a new U.S. Patent application filed concurrently herewith entitled METHOD AND APPARATUS FOR STORING MPEG-2 TRANSPORT STREAMS USING A CONVENTIONAL DIGITAL VIDEO RECORDER, including the required fees, are being deposited with the United States Postal Service as express mail in an envelope addressed to: Assistant Commissioner for Patents, Box Patent Application, Washington, D.C. 20231 on December 16,1999.

The specific documents served herewith are:

- | | |
|---|-------------------------|
| 1. Utility Patent Application Transmittal | 10. Power of Attorney |
| 2. Fee Transmittal (in duplicate) | 11. Check #51866 in the |
| 3. Specification (17 pages) | amount of \$1,244.00 |
| 4. Drawings (6 pages) | 12. Confirmation Card |
| 5. Declaration (3 pages) | |
| 6. Assignment | |
| 7. Recordation Form Cover Sheet | |
| 8. Certificate under 37 CFR §3.73(b)
With a copy of supporting documents | |
| 9. Associate Power of Attorney | |


Dwight Bergquist-Moody

METHOD AND APPARATUS FOR STORING MPEG-2 TRANSPORT STREAMS 5 USING A CONVENTIONAL DIGITAL VIDEO RECORDER

BACKGROUND OF THE INVENTION

The present invention relates to a digital video recorder and, more particularly, to a method and apparatus for storing a compressed MPEG-2
10 transport data stream with a conventional digital video recorder.

A conventional digital video (DV) recorder records a digitized version of an analog television signal. The analog signal may be the signal of the NTSC (National Television Systems Committee) color television system of the United States and Japan, the PAL (Phase Alteration Line Rate) television system of parts
15 of Europe, or the SECAM (Se'quentiel Couleur 'a Memoire) television system of France, Russia and eastern Europe. For example, to digitally record the analog television signal of the NTSC system, the separate luminance and chrominance signals of the video signal are first sampled and quantized. Intraframe compression is applied to the digital data representing the video signal using
20 techniques such as adaptive quantization (AQ), discrete cosine transformation (DCT), and variable length coding (VLC). Following compression, error correction is added to the data. The audio portion of the signal is processed in a similar manner. The digital audio and video data are copied to data elements of a digital video (DV) frame data structure and the audio and video data elements of the DV
25 frame structure are stored as separate segments of recording tracks on a magnetic tape.

The input and output of most DV recorders are by means of isochronous data transport as defined by the IEEE 1394-1995, STANDARD FOR A HIGH PERFORMANCE SERIAL BUS, incorporated herein by reference. The
30 IEEE 1394 standard defines a basic mechanism for real time data transport

including an isochronous data packet 10, as illustrated in FIG. 1. However, the IEEE 1394 standard does not establish the protocols needed for specific application requirements such as sending DV data over the bus. The format of the data structure for isochronous transmission of DV data across the IEEE 1394 serial bus is described in the International Standards Organization (ISO)/International Electrotechnical Commission (IEC) standards for DIGITAL INTERFACE FOR CONSUMER ELECTRONIC AUDIO/VIDEO EQUIPMENT, ISO/IEC 61883-1 and 61883-2, incorporated herein by reference. ISO/IEC 61883 defines the Common Isochronous Packet (CIP) format that is the basis of the 1394 DV data packet 30, illustrated in FIG. 2. The DV packet 30 comprises a CIP header 32 and a data field 34 of 480 bytes. For isochronous transmission on the IEEE 1394 bus, the DV data packet 30 is inserted into the data block of the IEEE 1394 isochronous data packet 10.

The IEEE 1394 bus sequences through three general phases: a cycle initiation phase, an isochronous phase, and an asynchronous phase. At the completion of the cycle initiation phase, transfer of isochronous data packets 10 is enabled. Devices connected to the bus having an allocated isochronous channel arbitrate for the bus. When a device gains access to the bus, it locates the start of the DV video frame and buffers the next 250 valid data packets to collect a complete DV frame. The CIP headers are discarded and the remaining 120,000 bytes defines an NTSC DV frame.

A 525 lines, NTSC DV video frame 50 comprises odd and even video fields and is encoded into ten digital interface format (DIF) sequences 52, as illustrated in FIG. 3. Each DIF sequence 54 comprises 150 DIF blocks 54 as illustrated in FIGS. 3 and 4. The 150 DIF blocks comprise a header (H) section 70, a subcode (SC) section 72, a video auxiliary (VAUX) section 74, and an audio and video data section 75. The audio data section 76 (indicated by a bracket in FIG. 4) comprises nine (A_0 - A_8) audio DIF blocks. The video portion of the audio-video section 75 comprises 135 (V_0 - V_{134}) video DIF blocks 78 (indicated by a bracket in FIG. 4). Referring to FIG. 3 each DIF block 54 includes an ID

section 56 and a data section 58.

Digital recording of analog television signals provides a number of advantages over analog recording of those signals. However, television is in transition from an analog system to a digital system based on the MPEG-2 video compression standard. In the digital television (DTV) system, signals for each of the elements of a television program are digitized. The digital elementary data streams are compressed and then multiplexed into a single MPEG-2 transport data stream for transmission to a receiver. At the receiver, the transport stream is separated into the constituent elementary data streams which are decompressed and presented to the viewer. MPEG-2 transport data streams can be recorded with a dedicated MPEG video recorder. However, purchasing a dedicated video recorder to record MPEG video, particularly during the transition to DTV, is an undesirable additional expense.

What is desired, therefore, is a method of storing an MPEG transport data stream on a conventional DV format video recorder for playback on a DTV receiver.

SUMMARY OF THE INVENTION

The present invention overcomes the aforementioned drawbacks of the prior art by providing a method of processing data comprising the steps of copying the data to a data block formatted for digital video, and storing the data block on a storage medium in a digital video storage format. For example, packetized MPEG-2 transport stream data can be stored on a conventional digital video (DV) recorder by copying the transport stream data to one or more digital interface format (DIF) data blocks that are part of a digital video (DV) frame data structure. The DV frames containing the transport stream data are then recorded on video tape. The DV frames can be input to the video recorder by insertion into isochronous data transfer packets for transfer over an IEEE 1394 bus. On the other hand, if the data is formatted according to MPEG or another data formatting standard supported by IEEE 1394, the data may be transferred to the recorder

before being inserted into a DV frame for storage. To present the stored data, the data is extracted from the DV frames and then decoded and presented using the customary applicable methods.

5 An apparatus for storing data with a digital video recorder is also disclosed comprising an accumulation buffer to accumulate a predetermined quantity of the data and a frame packetizer to copy the data to a data block of a digital video frame.

The foregoing and other objectives, features and advantages of the invention will be more readily understood upon consideration of the following
10 detailed description of the invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

15 FIG. 1 is an illustration of the data structure of an IEEE 1394 isochronous data packet.

FIG. 2 is an illustration of the data structure of a digital video data packet to be inserted into the data block of the IEEE 1394 isochronous data packet of FIG. 1.

FIG. 3 is an illustration of the data structure of a digital video frame.

20 FIG. 4 is an illustration of the data structure of a digital interface format (DIF) sequence of the digital video frame of FIG. 3.

FIG. 5 is a block diagram of a digital television (DTV) system, including a digital video recorder.

25 FIG. 6 is an illustration of the structure of a digital interface format (DIF) block of a DV frame in which MPEG transport stream data is stored.

FIG. 7 is an illustration of an embodiment of a header for the MPEG transport stream data stored in a digital interface format (DIF) block of a DV frame as illustrated in FIG. 6.

30 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 5, a digital television system comprises, generally, a transmitter or emission station 100 (indicated by a bracket), a transmission channel 102 (indicated by a bracket), a receiver 104 (indicated by a bracket), and a monitor 106. In the emission station 100, separate video 108, audio 110, and data 112 elementary data streams are appropriately encoded and compressed in video 114, audio 116, and data 118 encoders. The compressed elementary data streams are input to a program multiplexer 120 that combines the separate elementary data streams into a single transport data stream 122. The transport data stream 122 is transmitted to a receiver 104 over a transmission channel 102 such as a terrestrial or satellite broadcast system or a cable. At the receiver 104 which may be a set-top-box, the MPEG-2 transport data stream is separated into its constituent compressed video 124, audio 126, and data 128 elementary streams by a demultiplexer 130. The individual elementary data streams are decompressed and decoded in video 132, audio 134, and data 136 application decoders. The decompressed and decoded video 138, audio 140, and data 142 elementary streams are input to a presentation system 144 for presentation to the viewer, usually by display on the monitor 106.

The receiver 104 may be connected to a digital video (DV) format video recorder or camcorder 146 by a bus 148 conforming to the IEEE 1394-1995, STANDARD FOR A HIGH PERFORMANCE SERIAL BUS. In the present invention, the packetized MPEG-2 transport stream data 122 is inserted into a DV data packet by a frame packetizer 150. The DV frame is, in turn, inserted into an IEEE 1394 isochronous transfer data packet by an IEEE 1394 isochronous data encoder 152 for transmission over the IEEE 1394 bus 148 to the video recorder 146. In the video recorder 146, the DV data packets are recovered from the transfer data packets by a depacketizer 153 and the DV formatted frames are stored on a storage medium 154, usually a DV formatted magnetic videotape. At play time, the DV formatted data are inserted into an IEEE 1394 isochronous packet by an encoder 155 and transmitted over the bus 148 to the transmission channel 102 and to the receiver 104 where the MPEG data is extracted. The

MPEG transport stream data are decoded by the application decoders 132, 134, and 136 for display by the presentation system 144.

The IEEE 1394 standard also provides a mechanism for transferring data in an MPEG format over the serial bus 148. As an alternative embodiment, the transport stream data 122 could be encoded in the IEEE 1394 encoder as MPEG formatted data encapsulated in an IEEE 1394 packet. At the recorder 146, the MPEG data would be extracted from the IEEE 1394 data packet in the depacketizer 153. In this embodiment, the MPEG data would be inserted into the DV data format by a DV frame packetizer 157 in the recorder 146. The DV formatted data would then be stored on the storage medium 154. At play time, the DV formatted data would be copied from the storage medium 154 by the encoder 155. In the encoder 155, the MPEG data is extracted from the DV formatted data packets and then the MPEG data is inserted into an IEEE 1394 data packet for transmission over the serial bus 148. In this alternative embodiment, the MPEG data would be recovered from the IEEE 1394 packet in the reconstruction depacketizer 159.

The IEEE 1394 high speed serial bus 148 provides for both asynchronous and isochronous data transfer. Isochronous operation guarantees a bandwidth for devices, such as audio/video devices, that require constant data transfer rates. Isochronous transactions use a single isochronous data packet format to perform multicast or broadcast transfers to one or more nodes (attached devices) on the bus 148. The format of an IEEE 1394 isochronous data packet is illustrated in FIG. 1. The packet comprises, generally, a header 12 and a data block 14. The header 12 specifies the length of the data in the packet 16, an isochronous channel number 18 that identifies the nodes to which the isochronous transfer is to be directed, a transaction code 20, and a header cyclic redundancy check (CRC) 22. A cyclic redundancy check (CRC) 24 is also provided for the data block 14. The maximum data payload 26 (indicated by a bracket) of the isochronous data packet 10 varies with the data capacity of the specific IEEE

1394 serial bus. The maximum payload 26 of the smallest isochronous packet (for a 100 Mbit per sec. bus) is 1024 bytes. To transfer digital video format (DV) data over the serial bus, a DV data packet 30, as illustrated in FIG.2, is inserted into the data field of the IEEE 1394 isochronous data packet 10.

5 The structure of the DV data packet 30 is defined by ISO/IEC 61833-1 and 61833-2, DIGITAL INTERFACE FOR CONSUMER ELECTRONIC AUDIO/VIDEO EQUIPMENT, and is illustrated in FIG. 2. The DV data packet 30 comprises a CIP (Common Isochronous Packet) header 32 and a 480 byte data field 34. The CIP header 32 includes fields for source node identification (SID) 36, data block
10 size (DBS) 38, function number (FN) 40, quadlet packing count (QPC) 42, source packet header (SPH) 44, format identification (FMT) 46, signal type (STYPE) 48, and a time stamp (SYT) 49 for synchronization of video frames.

 The data of a DV frame 50 for NTSC television is divided into ten digital interface format (DIF) sequences 52 as illustrated in FIG. 3. A DV frame for PAL
15 television comprises 12 DIF sequences. As illustrated in FIGS. 3 and 4, each DIF sequence 52 comprises 150 DIF blocks 54. A DIF sequence 52 includes a header section (DIF block H0) 70, a subcode section (DIF blocks SC0 and SC1) 72, a video auxiliary section (DIF blocks VA0-VA2) 74, and an audio-video section 75. The audio-video section 75 comprises an audio section (DIF blocks
20 A0-A8) 76 (indicated by a bracket in FIG. 4), and a video section (DIF blocks V0-V134) 78 (indicated by a bracket in FIG. 4). Referring again to FIG. 3, each DIF block comprises a three byte identification (ID) 56 and a 77 byte data section 58. The DIF block ID 56 indicates the type of DIF block (for example, video), the subsequence number and the DIF block number (0 to 134).

25 In the present invention, MPEG-2 transport data stream packets are inserted into the last 76 bytes (the target data block) of the 77 byte data fields 58 of a plurality of video section DIF blocks 78 of one or more DV frames 50. Data is not stored in the first byte of the data field 58 because the DV recorder may alter the value of this byte as an error indicator. When writing to the recorder this byte
30 is usually set to zero indicating no error, although other values are possible. DV

frame packets 30, containing the DV formatted frames, are inserted into the payload of IEEE 1394 isochronous data transfer packets 10 for transfer over the IEEE 1394 bus. At the video recorder, the DV frames are extracted from the bus data stream and stored as DV formatted data on the videotape 154. Referring to

5 FIG. 6, in an embodiment of the invention, the first six bytes of the target data field (the last 76 bytes of the data field 58) are used for MPEG header information 80 and the remaining 70 bytes are used to store the packetized MPEG-2 transport stream data 82. The MPEG header 80 is used by the decoder in extracting

10 FIG. 7, the MPEG header comprises a length field 86 specifying the number of bytes of MPEG data in the DIF block starting from the MPEG ID byte 88 and ending at the last MPEG transport stream data byte of the DIF block 54. If a DIF block contains no MPEG data, the final four fields of the MPEG header 80 will contain no data and the length field 86 will be zero. The MPEG-2 ID field 88

15 contains a unique number that indicates that the data block of the DIF block contains MPEG-2 data. For example, the unique number might be the ASCII character "M" that has the value 77. The version field 90 contains a number indicating the version of the MPEG-2 standard and any MPEG-to-DV data storage specification applicable to the data in the block. On the other hand, the

20 MPEG ID 88 and version 90 fields could be eliminated if the data is known to be MPEG-2 data or if the transport stream validity is checked by the MPEG decoder.

The redundancy field 92 of the DIF block contains an incrementing number indicating when new data is being stored in the DIF block. The DV format utilizes intraframe compression. The MPEG-2 compression process utilizes both

25 intraframe and interframe data compression. The inventors realized that the 22.68 Mbps data capacity of the DV tape may substantially exceed the data rate of the MPEG transport stream 122. For example, standard definition MPEG-2 video has a maximum data rate of six Mbps. When the data rate capacity of the tape exceeds the data rate of the MPEG transport stream, the MPEG data can be

30 stored redundantly on the tape. At 30 frames per second, approximately 200,000

bits of MPEG data must be stored in each DV frame structure 50. However, each DV frame 50 has a data capacity of 756,000 bits and the extra capacity can be used to redundantly store the MPEG data in multiple DIF blocks. If a DIF block is lost in transmission or storage, the data can be recovered from an identical DIF block in another DIF sequence. Further, when operating in a trick play mode the IEEE 1394 data stream may contain only fragments of each DV frame.

Depending on trick play speed and data redundancy, it may be possible to reconstruct the original MPEG-2 transport stream from fragments of the DV frames. The redundancy value is a function of the DV frame structure capacity (756,000 bits) and the MPEG-2 data rate and can be expressed as:

$$Redundancy = \text{floor} \left[\frac{DVC_frame_capacity \cdot DVC_frame_rate}{MPEG2_bit_rate} \right]$$

Referring to FIG. 5, to control the redundant storage of MPEG data, the receiver 104 accumulates 756,000 bits (one DV frame of data) in an accumulation buffer 158 as the MPEG transport stream data arrives at the receiver 104 from the emission station 100. When this quantity of data has been accumulated, it is placed in the data section of a DV frame 50. This data is repeatedly output to the frame packetizer 150 while the next 756,000 bits of data are received from the emission station 100 and accumulated. The DV packet 30 is sent to the video recorder 154 and the new accumulation of data is then placed in a new DV frame with a redundancy number incremented by one from that of the previous DV frame. The process is repeated until the entire MPEG transport stream is stored.

When the stored video is played, the data in the DV frames stored on the tape is sent from the recorder 154 to the receiver 104. The MPEG ID field 88 of MPEG header 80 (see FIG. 7) is used to identify the data in the DV frames as MPEG transport stream data. The offset field 94, see FIG.7, is used to reconstruct the MPEG-2 transport stream. The offset specifies the position of the MPEG data in the DIF block relative to the MPEG data from other DIF blocks of

the current DV frame or in redundant frames. Preferably, the first DIF block of a DV frame has an offset of zero. If this DIF block contains 70 bytes of data, then the offset number of the next DIF block would be 70.

The transport stream is reconstructed by extracting the MPEG data from the IEEE 1394 packets in a reconstruction depacketizer 159 and then placing the MPEG-2 data from each of the DIF blocks 54 into a reconstruction buffer 156, illustrated in FIG. 5. The location of specific data in the reconstruction buffer 156 is the sum of the offset value 94 and a frame storage index equal to one byte past the last storage location used by the DVC frames having the previous redundancy value. The frame storage index is initially set to zero. If any DIF blocks are missing, redundant DIF blocks 54 from redundant DV frames can be placed into the reconstruction buffer 156. When a frame with a new redundancy value is received, the frame storage index is set to one byte past the last byte stored with the previous redundancy value 92. The MPEG data from the redundant frame is then stored at the location identified by the sum of the offset value 94 of the DIF block and the frame storage index. Data from each set of frames with a new redundancy value 92 is appended to the data in the reconstruction buffer 156. A discontinuity in the redundancy value would indicate that a new or discontinuous MPEG-2 transport stream is being received.

The method and apparatus of the present invention may be used to store data other than MPEG-2 transport stream data on DV tape. For example, files from a PC hard disk or other data that may or may not be related to stored MPEG transport stream data (such as web page uniform resource locators (URLs), recording time, or system information) could be stored on DV tape utilizing the method. Further, if the data rate capacity of the DV tape exceeds the data rate of the MPEG transport stream, ancillary data can be stored by the DV recorder utilizing the method. Such ancillary data could include trick play frames to aid in trick play operation (such as, fast forward or reverse operation) of the video recorder. The trick play mode data may include MPEG frames stored redundantly on the tape to ensure that data is can be retrieved during fast play modes.

All the references cited herein are incorporated by reference.

The terms and expressions that have been employed in the foregoing specification are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of
5 the features shown and described or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims that follow.

What is claimed is:

1. A method of processing data comprising the steps of:

- 5 (a) copying said data to a data block formatted for digital video; and
 (b) storing said data block on a storage medium in a digital video storage
 format.

2. The method of claim 1 wherein said storage medium comprises a digital
video tape.

10

3. The method of claim 1 further comprising the step of copying said data block
to a payload portion of an isochronous data transfer packet.

4. The method of claim 1 further comprising the step of repeating said copying
of said data to another said data block.

15

5. A method of storing MPEG transport stream data on a digital video recorder
comprising the steps of:

20

- (a) copying said transport stream data to a video data block of a digital
 video frame; and
 (b) storing said digital video frame on a storage medium.

6. The method claim 5 wherein said storage medium comprises a digital video
tape.

25

7. The method of claim 5 further comprising the step of copying said digital video
frame into an isochronous data transfer packet.

8. The method of claim 5 further comprising the step of repeating said copying of said transport stream data to another said video data block.

5 9. The method of claim 8 wherein said another video data block is a data element of another said digital video frame.

10. A method of storing MPEG transport stream data with a digital video recorder comprising the steps of:

- 10 (a) copying said transport stream data to a data block of a digital video frame;
- (b) copying said digital video frame to an isochronous data packet;
- (c) extracting said digital video frame from said isochronous data packet; and
- (d) storing said digital video frame in a storage medium.

15 11. The method of claim 10 further comprising the step of repeating said copying of said transport stream data to another data block.

20 12. The method of claim 11 wherein said another video data block is a data element of another said digital video frame.

13. A method of storing MPEG transport stream data on a digital video recorder comprising the steps of:

- 25 (a) copying said transport stream data into an isochronous data transfer packet;
- (b) extracting said transport stream data from said isochronous data transfer packet;

- (c) copying said transport stream data to a video data block of a digital video frame; and
- (d) storing said digital video frame.

5 14. The method of claim 13 further comprising the step of repeating said copying of said transport stream data to another data block.

15. The method of claim 14 wherein said another video data block is a data element of another said digital video frame.

10

16. A method of storing MPEG transport stream data with a digital video recorder comprising the steps of:

- (a) accumulating a quantity of said transport stream data equal to a digital video frame data quantity;
- 15 (b) copying said quantity of said transport stream data to a data block of a digital video frame;
- (c) repeating said copying of said quantity of said transport stream data to another said data block as another said quantity of transport stream data is accumulated;
- 20 (d) copying at least one said digital video frame including said data block to a data transfer packet;
- (e) extracting said at least one digital video frame from said data transfer packet; and
- (f) storing said at least one digital video frame.

25

17. A method of storing MPEG transport stream data with a digital video recorder comprising the steps of:

- (a) copying said transport stream data to a data transfer packet;
- 30 (b) extracting said transport stream data from said data transfer packet;

- (c) accumulating a quantity of said transport stream data equal to a digital video frame data quantity;
- (d) copying said quantity of said transport stream data to a data block of a digital video frame;
- 5 (e) repeating said copying of said quantity of said transport stream data to another said data block as another said quantity of transport stream data is accumulated; and
- (f) storing said digital video frame.
- 10 18. An apparatus for storing data with a digital video recorder comprising:
- (a) an accumulation buffer to accumulate a predetermined quantity of said data; and
- (b) a frame packetizer to copy said data to a data block of a digital video frame.
- 15 19. The apparatus of claim 18 further comprising:
- (a) a transfer packet encoder to copy said digital video frame to a data transfer packet; and
- (b) a depacketizer to extract said digital video frame from said data transfer packet for storage.
- 20 20. A method of processing data comprising the steps of:
- (a) copying a digital video data block containing said data from a storage medium;
- 25 (b) extracting said data from said digital video data block; and
- (c) formatting said data in a format other than the format of said digital video data block.
21. The method of claim 20 wherein said storage medium comprises a digital video tape.
- 30

22. The method of claim 23 further comprising the step of copying said formatted data to a payload portion of an isochronous data transfer packet.

- 5 23. The method of claim 20 wherein the step of copying said digital video data block from said storage medium comprises the steps of:
- (a) copying said digital video data block to a payload portion of an isochronous data transfer packet; and
 - (b) extracting said digital video data block from said isochronous data transfer packet.

10

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000

ABSTRACT OF THE DISCLOSURE

5 A method and apparatus for storing an MPEG-2 transport data stream with a conventional digital video (DV) recorder is described. The packetized MPEG-2 transport stream data is inserted into a data block of a digital video (DV) frame. The digital video frame is stored on the storage medium of the DV recorder. The DV frame may be inserted into an isochronous data transfer packet for transfer to
10 the recorder over an IEEE 1394 serial bus. On the other hand, the MPEG transport stream data may be transferred to the recorder over the IEEE 1394 serial bus before the data is inserted into the DV frame for storage. For playback, the stored DV frame can be copied into an IEEE 1394 packet for transfer to the television receiver where the MPEG data is extracted from the frame, decoded
15 and presented. On the other hand, the MPEG data may be extracted from the stored DV frame before transfer to the receiver over the IEEE 1394 bus.

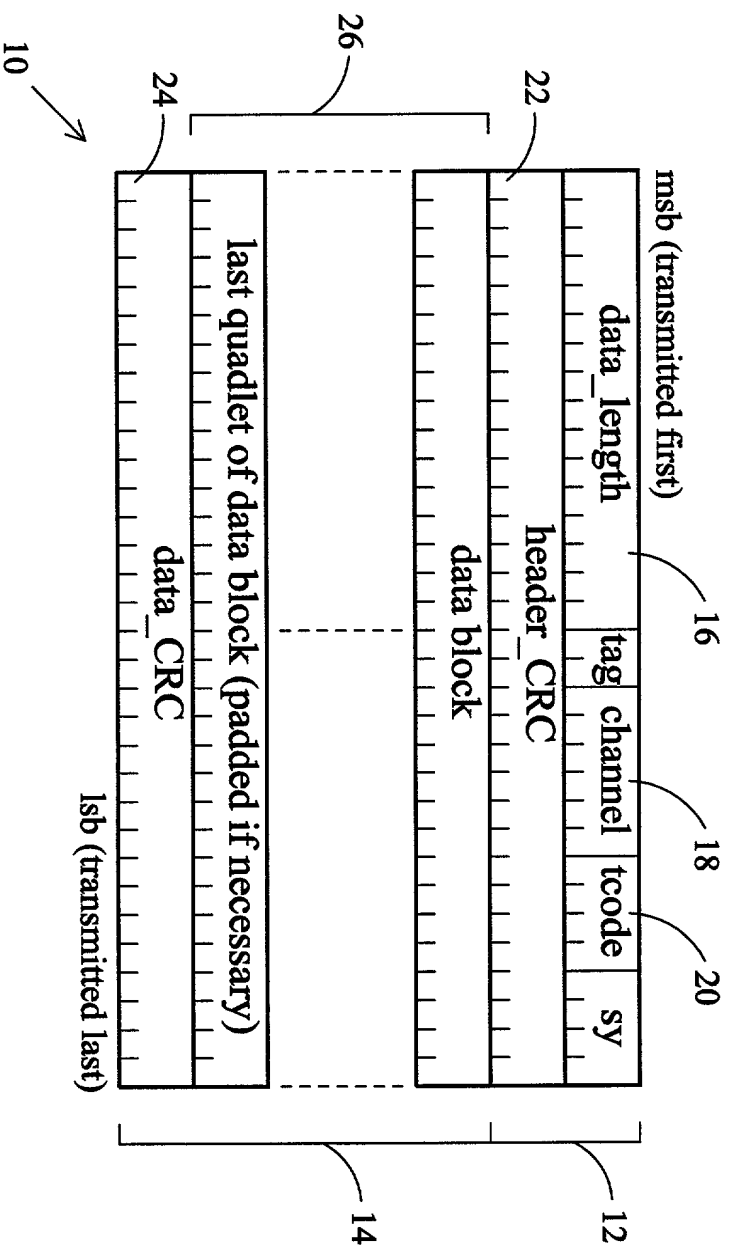


FIG. 1
(PRIOR ART)

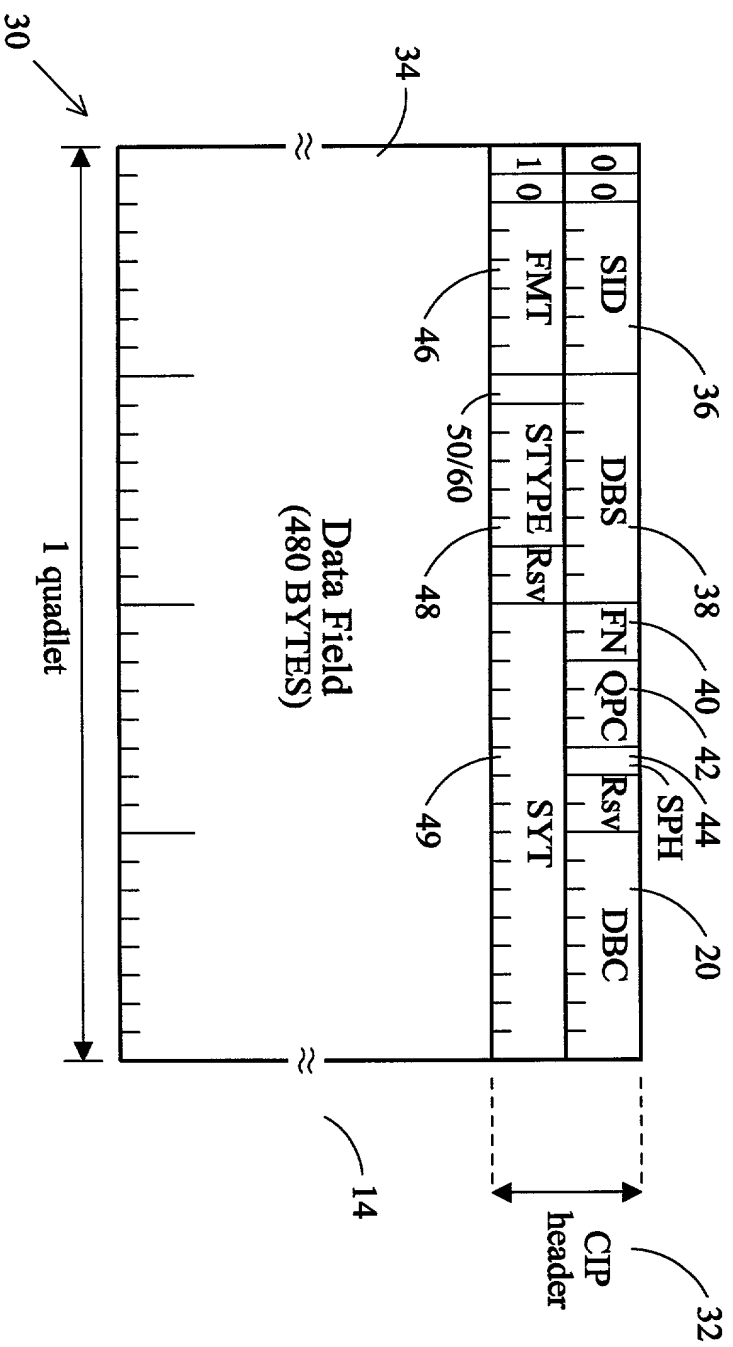
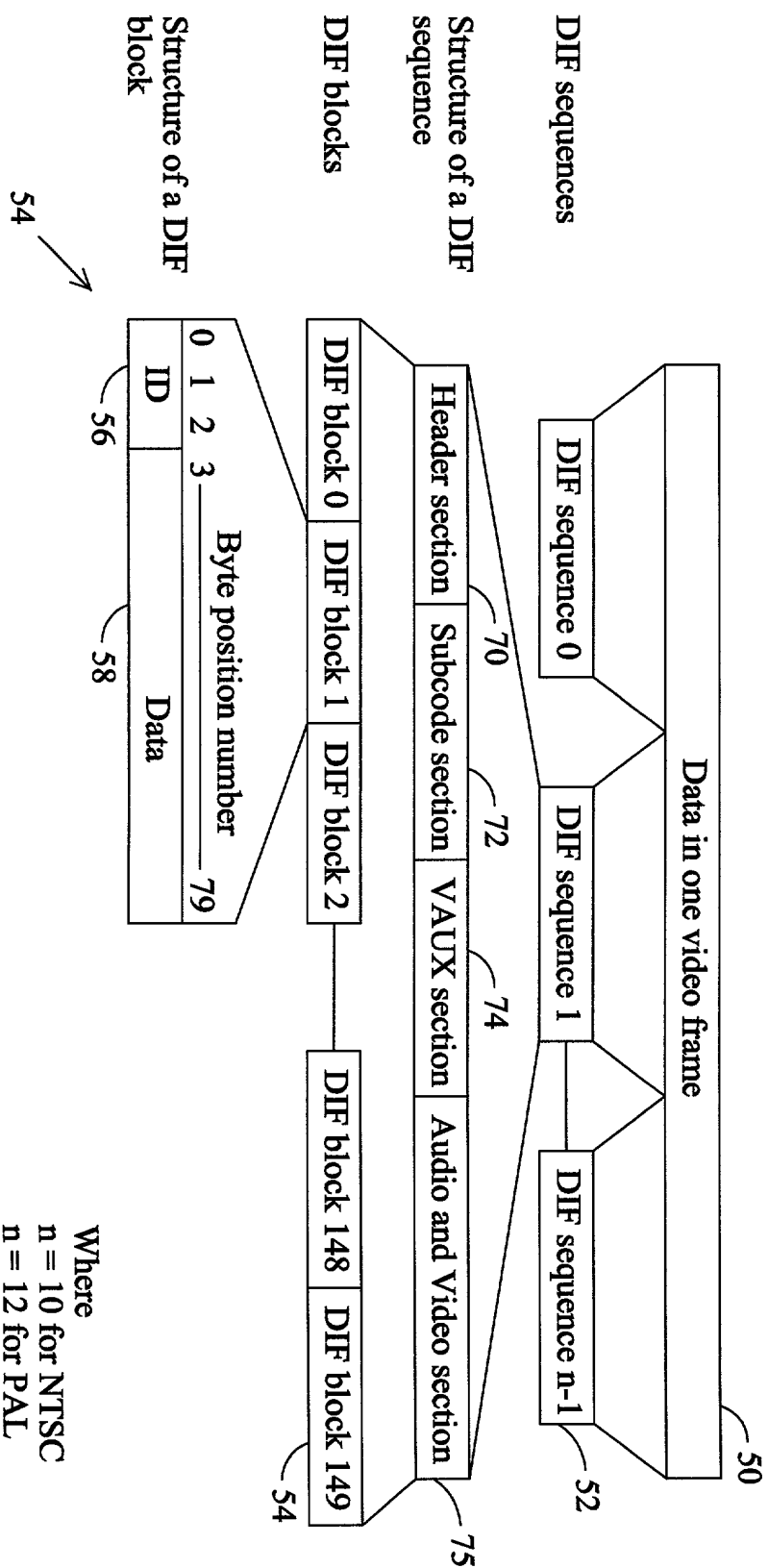


FIG. 2
(PRIOR ART)



Where
 n = 10 for NTSC
 n = 12 for PAL

FIG. 3
 (PRIOR ART)

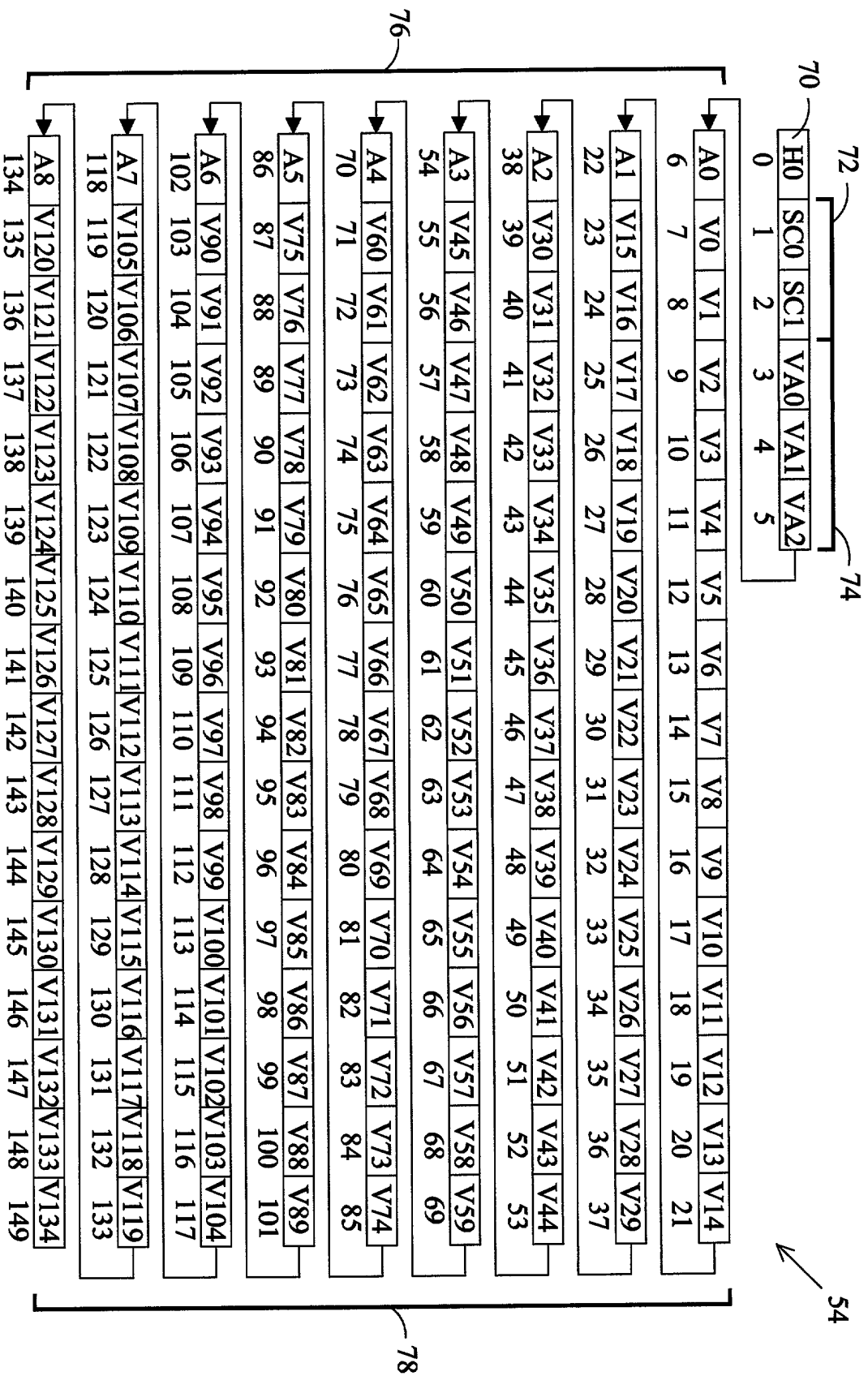


FIG. 4
(PRIOR ART)

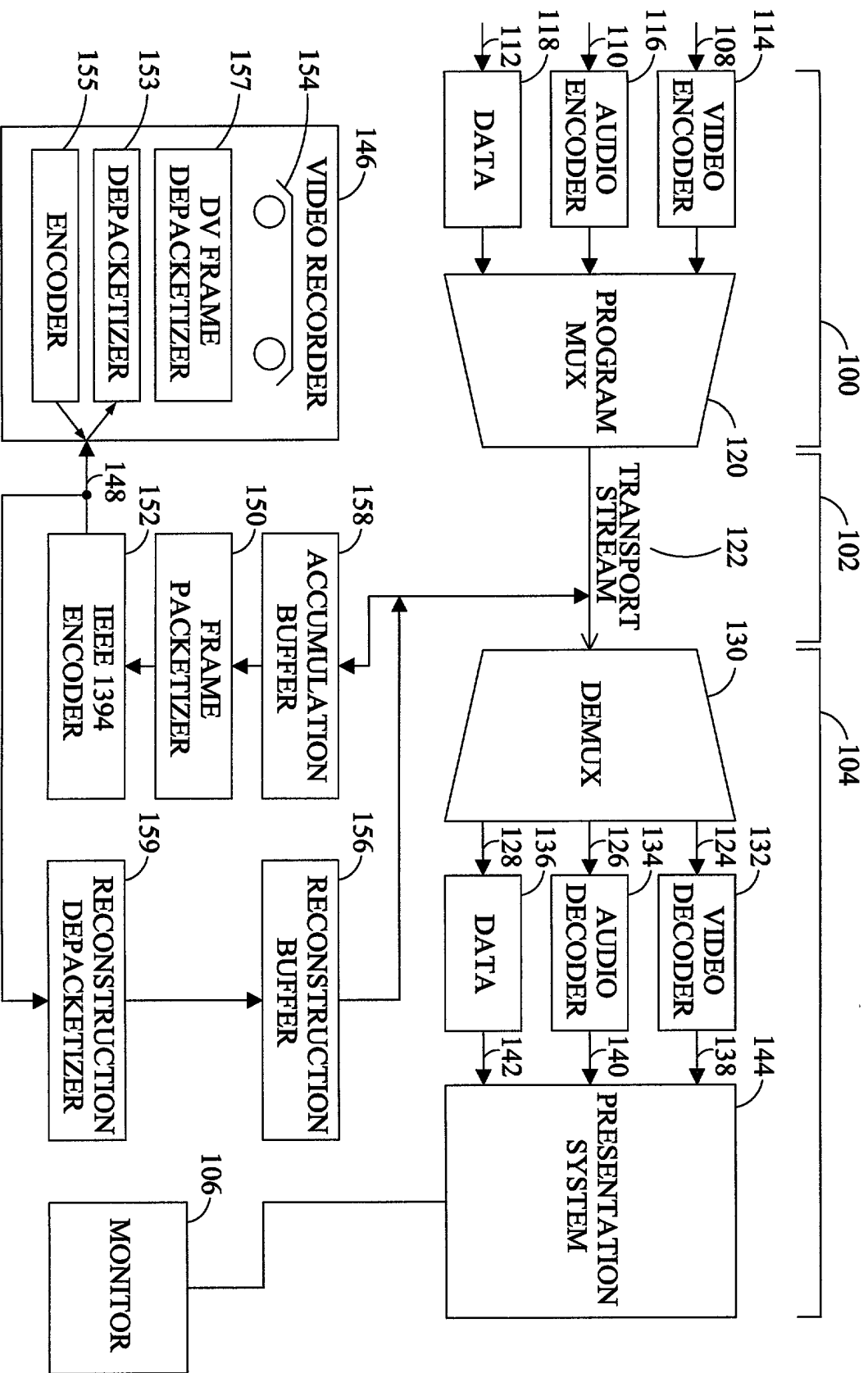


FIG. 5

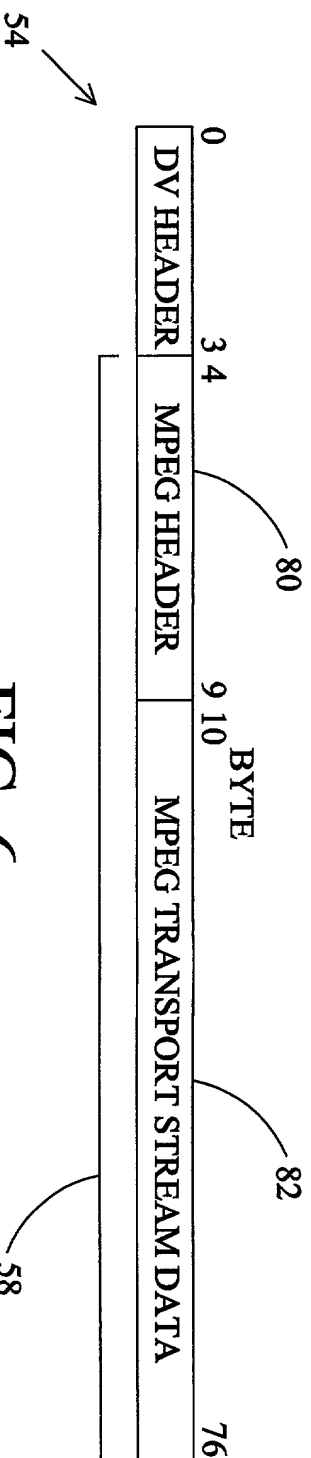


FIG. 6

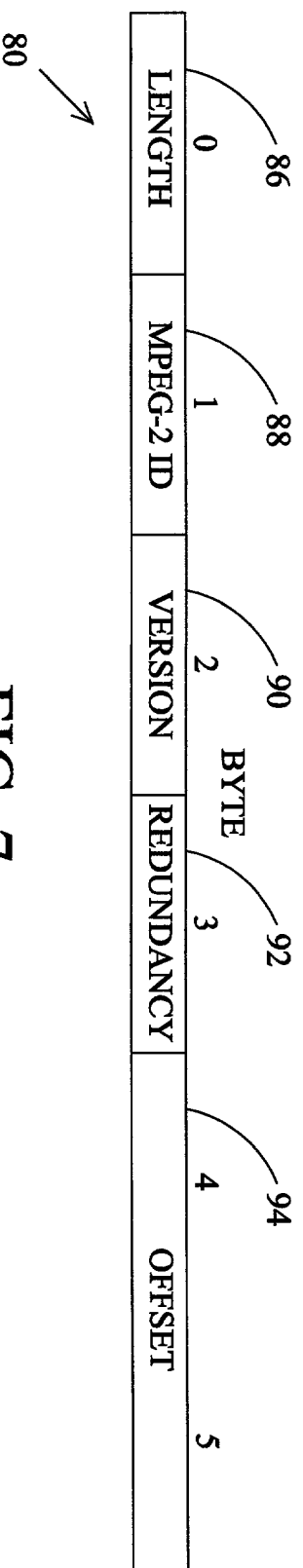


FIG. 7

DECLARATION AND POWER OF ATTORNEY

As the below named inventors, we hereby declare that:

Our residence, post office address and citizenship are as stated below next to our names,

We believe we are the original, first and sole inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR STORING MPEG-2 TRANSPORT STREAMS
USING A CONVENTIONAL DIGITAL VIDEO RECORDER

the specification of which

☒ is attached hereto.

was filed on _____ as
☐ Application Serial No. _____
and was amended on _____.
(if applicable)

We hereby state that we have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above.

We acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56.

We hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Priority
Claimed

_____	_____	_____	<input type="checkbox"/> Yes <input type="checkbox"/> No
(Number)	(Country)	(Day/Month/Year Filed)	
_____	_____	_____	<input type="checkbox"/> Yes <input type="checkbox"/> No
(Number)	(Country)	(Day/Month/Year Filed)	

We hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below.

(Application Serial No.)

(Filing Date)

We hereby claim the benefit under Title 35, United States Code, § 120, of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, we acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Ser. No.)

(Filing Date)

(Status)

(patented, pending,
abandoned)

(Application Ser. No.)

(Filing Date)

(Status)

(patented, pending,
abandoned)

We hereby appoint Jacob E. Vilhauer, Jr., Reg. No. 24,885, Charles D. McClung, Reg. No. 26,568, Dennis E. Stenzel, Reg. No. 28,763, Donald B. Haslett, Reg. No. 28,855, William O. Geny, Reg. No. 27,444, Timothy A. Long, Reg. No. 28,876, J. Peter Staples, Reg. No. 30,690, Kevin L. Russell, Reg. No. 38,292, Bruce W. DeKock, Reg. No. 40,585, Nancy J. Moriarty, Reg. No. 40,733, and Timothy E. Siegel, Reg. No. 37,442, all of the firm of Chernoff, Vilhauer, McClung & Stenzel, LLP, 1600 ODS Tower, 601 S.W. Second Avenue, Portland, Oregon 97204, telephone number 503-227-5631, our attorneys, jointly and individually, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false

statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: 12/13/99
Full name of inventor
Residence
Citizenship

Bryan Severt Hallberg
Bryan Severt Hallberg
7519 NE 152nd Ct
Vancouver, WA 98682
United States of America

Dated: 12/13/99
Full name of inventor
Residence
Citizenship

Jeff Brian Sampsel
Jeff Brian Sampsel
27419 NE Bradford Road
Vancouver, WA 98682
United States of America

→ JEFFREY BRIAN SAMPSEL

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Bryan S. Hallberg & Jeffrey B. Sampsell

Group Art Unit:

Serial No.:

Examiner:

Filed : Concurrently herewith

Title : METHOD AND APPARATUS FOR STORING MPEG-2 TRANSPORT
STREAMS USING A CONVENTIONAL DIGITAL VIDEO RECORDER

Assistant Commissioner for Patents
Washington, D.C. 20231

ASSOCIATE POWER OF ATTORNEY (37 C.F.R. 1.34)

Please recognize as Associate Practitioner in this case:

Name of Practitioner: Julie L. Reed

Address: 5750 NW Pacific Rim Blvd.

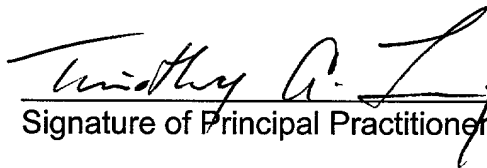
Camas WA 98607

Reg. No. 35,349

Tel. No. (360) 817-7651

CORRESPONDENCE

All correspondence concerning this application is to be directed to the **principal practitioner of record** at the **address below**.



Signature of Principal Practitioner of Record

Reg. No. 28,876

Timothy A. Long

Chernoff, Vilhauer, McClung & Stenzel L.L.P.
1600 ODS Tower
601 SW Second Avenue
Portland, OR 97204

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE UNDER 37 CFR §3.73(b)

Applicant : Bryan Severt Hallberg and Jeffrey Brian Sampsell
Serial No : _____ Filed: Concurrently herewith
Title : METHOD AND APPARATUS FOR STORING MPEG-2 TRANSPORT STREAMS
USING A CONVENTIONAL DIGITAL VIDEO RECORDER

Sharp Laboratories of America, Inc.
(Assignee)

a Washington Corporation

(Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

certifies that it is the assignee of the entire right, title and interest in the patent application identified above by virtue of either:

A. ☒ An assignment from the inventor(s) of the patent application identified above, a copy of which is submitted herewith.

OR

B. ☐ A chain of title from the inventor(s), of the patent application identified above, to the current assignee as shown below:

1. From: _____ To: _____
The document was recorded in the Patent and Trademark Office at Reel _____, Frame _____, or for which a copy is attached.
2. From: _____ To: _____
The document was recorded in the Patent and Trademark Office at Reel _____, Frame _____, or for which a copy is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet.

☐ Copies of assignments or other documents in the chain of title are attached. (Where one or more of the documents is unrecorded.)

The undersigned has reviewed all the documents in the chain of title of the patent application identified above and, to the best of undersigned's knowledge and belief, title is in the assignee identified above.

The undersigned (whose title is supplied below) is empowered to sign this Certificate on behalf of the assignee.

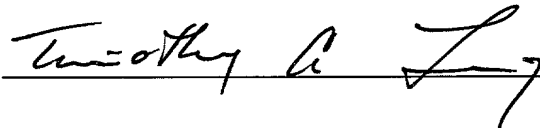
I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code,

and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date : December 16, 1999

Name : Timothy A. Long

Title : Attorney for the Assignee (a copy of the Power of Attorney is attached)

Signature : 

Chernoff, Vilhauer, McClung & Stenzel
1600 ODS Tower
601 S.W. Second Avenue
Portland, Oregon 97204
Tel: (503) 227-5631